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MAKING USE OF SATELLITE NET INTERCONNECTIONS TO REALIZE INTEGRATED ATM BROAD BAND COMMUNICATIONS NETWORKS

Duan Xiaoming Jyu Dehang

Translation of "Li Yong Wei Xing Lian Wang Shi Xian ATM Zong He Kuan Dai Tong Xin Wang"; Space Electronics Technology, No.2, 1995, p 1-6,48

ABSTRACT Making use of satellites to take networks which are separated from each other by relatively great distances in geographical terms and using them to realize the requirements associated with integrated broad band communications networks is just in the midst of constant growth. Moreover, applications associated with ATM technology make this type of network possess enticing development prospects. This article carries out discussions with regard to FDMA integrated broad band communications network structure and surface connection set ups, focusing on discussions of problems associated with net interconnection agreements and the area of network management.

KEY WORDS Broad band communications Satellite communications Network interconnections Asynchronous transmission mode

I INTRODUCTION

Following along with huge growth in regard to information requirements and constant enlargement of the range of external communications, people feel a pressing need to take various types of special use networks (for example, computer LAN, small forms of PABX nets, and so on) and connect them together in order to achieve the objectives of sharing of resources within broad areas, exchange of information, and mutual communications. This type of network interconnection is capable of using surface lines (for example, public networks and dedicated networks) or space links (for example, satellite communications) for realization. Due to the fact that satellite communications possess advantages which surface lines cannot compare to--such as long communications ranges and large coverage areas, wide transmission frequency bands, as well as high communications quality, and so forth--as a result, they are particularly appropriate for use in communications associated with undeveloped regions which are out of the way or have inconvenient communications. Methods associated with making use of satellite services to take specialized use networks which are separated from one another comparatively far in geographical terms and connecting them together to form a broad area network are attracting serious

attention from people more and more. This is because satellite networks possess the advantages associated with network flexibility and seeing investments comparatively fast. They are very suitable for use in developing nations, which have foundation telecommunications facilities that are not developed or are lacking, to rapidly alter the status of their backward communications conditions. The area of China is vast. Undeveloped, economically backward regions account for a very large proportion of it. As a result, making use of communications satellite network interconnections to construct pannational integrated communications networks--with regard to improving the backward state of communications in vast hinterland regions and areas with complicated topography--possesses a very important significance.

This article discusses--in satellite communications services--opting for the use of asynchronous transmission modes (ATM) in order to realize interconnections between local networks (such as LAN, MAN, and PABX) which are distantly separated in geographical terms. Discussions lay stress on problems associated with areas of connections between satellite networks and surface special use networks as well as network interconnection agreements. The reason for the use of ATM methods in satellite communications and not opting for the use of other transmission conventions which are currently in existence is primarily that future development toward integrated service digital networks provides the most extensive possibilities. This point is particularly important with regard to setting up integrated broad band communications networks (IBCN).

II. NETWORK STRUCTURES AND COMMUNICATIONS CHANNEL MULTIPLE ADDRESS QUERIES

Satellite communications possess very strong propagation characteristics. Within their coverage zones, various areas participating in communications are not subject to geographical conditions or limitations associated with the objects of their communications. As a result, with a communications satellite in orbit, it is then equivalent to covering a broad region with an invisible circuit capable of reaching any point--causing the composition of satellite networks to possess very great flexibility. It is possible to construct very complicated network forms in order to satisfy different user requirements [1]. /2

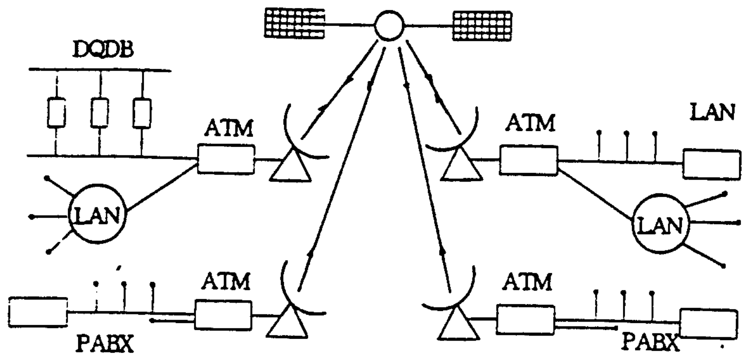

Fig.1(a) Integrated Broad Band Communication Network System Form

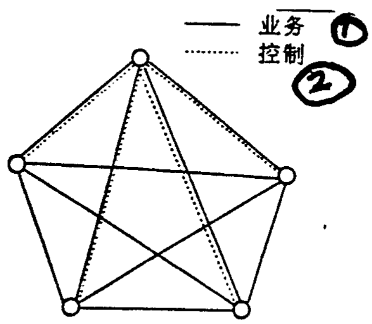

Fig.1(b) Topological Network Structure (1) Service (2) Control

Fig.1 clearly shows the system form associated with ATM integrated broad band communications networks and network architecture. In Fig.1(a), satellite operating frequency band is the C wave band or the Ku wave band. Transponder types are one time frequency variable transparent models. Their radio frequency band widths are capable of reaching 500MHz. Systems opt for the use of multiple circuit multiple use frequency division multiple address (FDMA) communications systems. Modulation method is QPSK. Transmission protocol is ATM mode. Network transmission architecture is a single jump type mesh network. The network management structure is a star shaped net. One surface station acts as central station, supplying monitoring, control, and management functions for the satellite system as a whole. Each surface station is interconnected in all cases through an ATM switching node and dedicated surface networks. This ATM switching node plays a net switch role, realizing agreement conversion and

connection functions between satellites and surface nets.

Network multiple address cut ins opt for the use of multichannel single carrier wave (MCPC) satellite communication methods. The system is TDM-QPSK-FDMA. It is a type of satellite communication system where performance is superior and prices are inexpensive. Compared to SCPC systems, it is more appropriate for use in trunk line communications with comparatively large numbers of services. Moreover, it is also simpler than TDMA systems. There is no requirement for full net synchronicity. Equipment is also relatively cheap. In conjunction with this, it is capable of satisfying user requirements for the transmission of various types of digital information--providing communications quality which conforms to ISDN requirements and facilitating ISDN interconnection. As a result, MCPC methods are developing rapidly. They are one of the multiple address cut in technologies recommended by international satellite organizations. In communication systems associated with MCPC methods, each earth station is allotted a dedicated carrier wave. During transmissions, PCM voice and data are first made multiple use of by time division. After that, phase shift keying control is carried out with respect to carrier waves. After going through transformations, information is then taken and sent to satellites. When received, the receiving side first verifies the target address of the sending side. Following that, from demodulation signals, information relevant to that station is extracted. Information sent to other stations is discarded. Obviously, in order to be able to receive all the information sent to stations, each ground station must, in all cases, possess down link frequency circuits associated with receiving all other stations after going through satellite repeating. In conjunction with this, on the basis of different carrier wave frequencies, distinction is made between different sending station addresses.

After option is made for the use of ATM modes and, in conjunction with that, group division and time division multiple utilization methods, it is possible to very conveniently select ways of transmitting information. On the sending side, time division reuse takes group divisions as units for its being carried out. Moreover, the length of each subgroup is 53 character groups. In these, 5 character groups are used as ATM markers. 48 character groups are information data. As far as ATM switching nodes are concerned, on the basis of the target address associated with each data subgroup, corresponding ATM markers are added for respective signal elements. After that, going through multichannel group division time division reutilization, a certain subgroup is taken to construct a data frame. In conjunction with this, prepositioned frame header codes are added. After they are sent to modulator/demodulator devices for modulation, they are sent by transmitters into satellite channels. When received, ATM nodes decide whether or not they are subgroups of reception signal elements in accordance with virtual passage (VPI value) tables maintained in local data banks. If the VPI values contained in signal element subgroup markers which are received are values in

local VPI tables, then, this signal element is received. Otherwise, VPI values are discarded and do not fall into all the signal element subgroups in local VPI tables. As a result, making use of the propagation characteristics of satellites, each surface station in systems is, in all cases, capable, among multiple communications channel down link frequencies from satellites, of extracting signal elements relevant to the station in question on the basis of ATM signal element markers, thus setting up mutual communications between any two sides or multiple sides. Fig.2 clearly shows ATM signal element structure and signal element time division reuse frame structure. In reutilization frame structures, signal elements can be divided into specified signal elements and nonspecified signal elements. Specified signal elements are specially used in digital voice or digital imagery services. However, nonspecified signal elements are used in data and facsimile services. Prepositioned codes include such contents as carrier wave recovery, bit timing, frame synchronicity, monitoring and control pulses, as well as service pulses, and so on. In order to make full use of communications channels and improve transmission rates, multichannel reutilization devices should be able, on the basis of business requirements, to adjust the ratios associated with two types of signal elements. For instance, when daytime voice service is busy, it is possible to allocate more of these specific signal units, but, at night, by contrast, it is possible to allocate more unspecified signal elements to provide uses associated with data transmission, so as to achieve high efficiency operation of systems. Of course, in order to guarantee that, when voice services are busy, digital information is not lost, there should be set up in each surface reutilization device, adequate storage space. /3

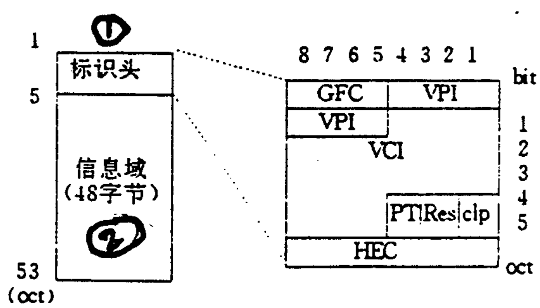

Fig.2(a) ATM Signal Element Structure (1) Marker (2) Data Region (48 Character Groups)

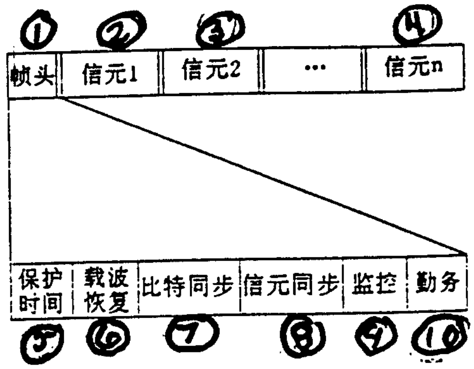

Fig.2(b) Signal Element Reutilization Frame Structure (1) Frame Header (2) Signal Element 1 (3) Signal Element 2 ... (4) Signal Element n (5) Protection Time (6) Carrier Wave Restoration (7) Bit Synchronicity (8) Signal Element Synchronicity (9) Monitoring and Control (10) Services

III. SURFACE STATION TERMINAL EQUIPMENT COMPOSITION AND ATM NODE CONNECTION SET UPS

Among systems that this article discusses, the sending side needs to know frame start times and signal element initiation instants. Only then is it possible to carry out multichannel signal element time division operations, achieving the objective of subgroup time division reutilization. The receiving side, by contrast, needs to extract frame synchronicity, signal element synchronicity, and bit synchronicity data in various circuit carrier waves. Only then is it possible to carry out correct demodulation-precisely determining optimum decision moments. Fig.3 gives a simplified line and block chart for a type of terminal equipment which is capable of completing TDM/FDMA functions. At transmitting terminals, voice relay and data relay signals coming from ATM switching nodes go through buffers after which they are sent to multichannel reutilization devices where time division reutilization is carried out. In conjunction with this, prepositioned frame header codes are added. A transmission frame is then formed. After going through QPSK modulators, they are sent out from transmitters. Because signals which come from ATM nodes and go out through relay trunk lines are generally all associated with users having comparatively low bit flow speeds, within the time period of a frame, they will be quickly sent to modulators. It is, therefore, necessary to have a compression storage device

associated with storing a frame, taking a frame of low speed data signal and compressing it into a high speed data frame. As the reverse of this, at receiving terminals, there is, by contrast, a need for an expansion storage device. As a result, buffer storage devices, in actuality, are speed converters.

At receiving terminals, N-1 channels corresponding to N-1 surface stations respectively receive signals possessing different carrier frequencies. The prepositioned codes associated with the channels in question are variously demodulated out. In conjunction with this, timing information is supplied on the basis of these codes. Signal element subgroups are extracted out from information frames. Before these signal element subgroups are taken and sent to expansion buffers, it is possible to make use of hardware circuitry to first carry out identification with regard to partial VPI (for instance, a few character groups spoken of earlier) among ATM signal elements. If certain character groups in front of VPI in signal elements are the same as specially designated address values given to the stations in question as fixed allocations, then, this signal element will be sent to buffers. If not, then the signal element subgroups in question are discarded. Using this type of method, it is possible to extract signal elements to send to the stations in question. In conjunction with this, buffer capacity requirements are reduced. After going through buffers, signal elements are sent to terminal ports associated with digital voice relays and data relays of ATM switching nodes. Then, ways are selected by switching nodes to send them through to user terminals on the basis of other VPI and VCI values. If there is a shortage of ATM entering relays (that is, smaller than the number of channels), it is possible, with regard to relay trunk lines, to opt for the use of dynamic allocation methods in order to resolve contradictions associated with insufficient communications channels.

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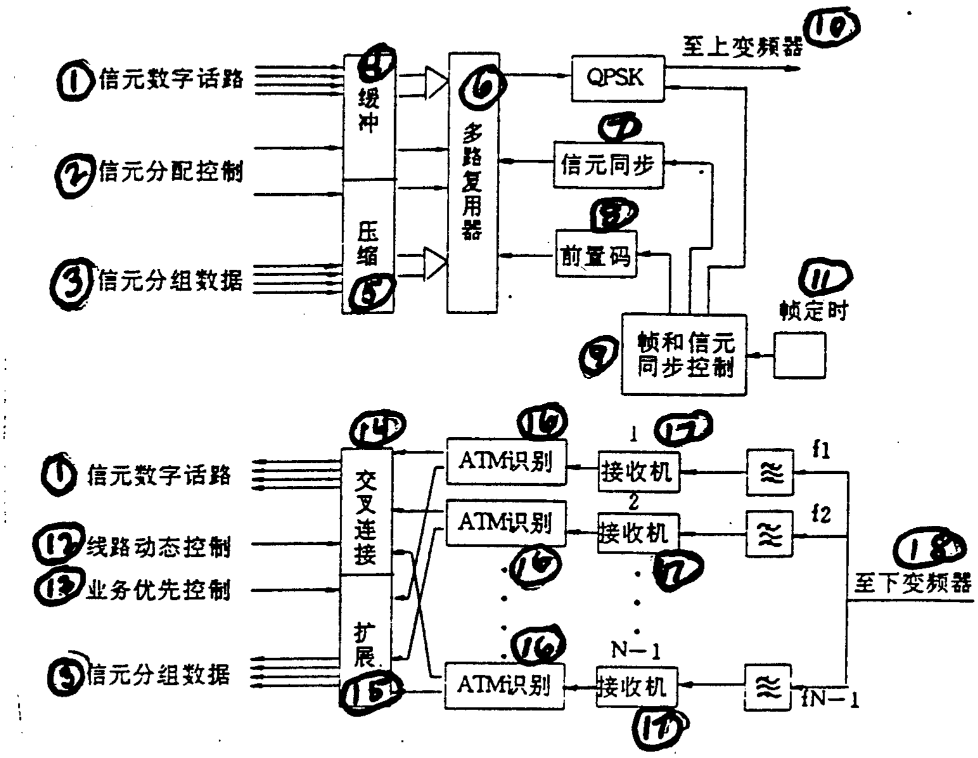

Fig.3 Simplified Line and Block Chart for Surface Station TDM/FDMA Terminal Equipment (1) Signal Element Digital Voice Circuits (2) Signal Element Allocation Control (3) Signal Element Subgroup Data (4) Buffer (5) Compression (6) Multichannel Reutilization Device (7) Signal Element Synchronicity (8) Prepositioned Code (9) Frame and Signal Element Synchronicity Control (10) To Upper Frequency Converter (11) Frame Timing (12) Dynamic Line Control (13) Service Priority Control (14) Cross Connections (15) Expansion (16) Identification (17) Receiver (18) To Lower Frequency Converter

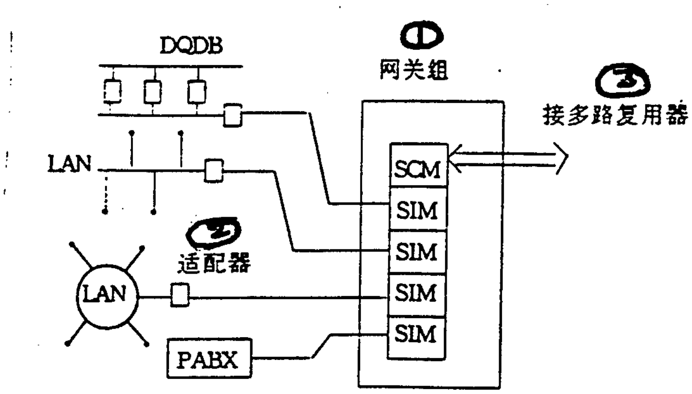

Fig.4 ATM Node and Surface Network Connection Set Up Design (1) Net Switching Unit (2) Adaptor (3) Multichannel Connection Reutilization Device

ATM switching nodes positioned between surface stations and surface networks play a net switch role. They do not permit voice or data service associated with the place in question to enter into satellite networks. In the area of connections between satellites and ground stations, ATM node output relay trunk lines connect to surface station multichannel reutilization devices, inputing to relay trunk lines connected to multichannel shunt systems. As far as the area of connections to surface networks is concerned, due to the fact that local networks opt for the use of data transmission agreements (for example, 802.3, 802.5, and 802.6) that are completely different from ATM agreements, there is, therefore, a need to resolve problems associated with protocol switchovers [2]. Besides this, there is no need to carry out agreement switchovers with regard to voice signals. It is only necessary to transmit in accordance with ATM subgroup reutilization signal element format, and that will do. Fig.4 gives one type of possible design for ATM node and surface network connection set ups. The design in question opts for the use of the concept of user net switch groups [3]. In the Fig., with regard to the various modules in subnetwork interconnection module groups (SIM), address filtering is respectively carried out on data sent in by different dedicated networks that are connected, subgroups are loaded, and there is conversion between ATM signal element format and subgroup data formats. Moreover, common interconnection modules (CIM) then complete ATM switching and transfer functions. Each SIM is capable, in all cases, of allocating one or a group of virtual passage indicators (VPI). Thus, on the basis of the corresponding VPI values--under the control of switching devices--each network is not only able to go through satellite and different area network communications. It is, moreover, also able to realize interconnections between different types of local networks. /5

IV. NETWORK INTERCONNECTION AGREEMENT STRUCTURES AND NETWORK MANAGEMENT

When considering terminal user network interconnection services, due to the fact that data transmission agreements used by special use surface networks and ATM transmission protocols are different, it is, therefore, necessary to resolve agreement switchovers between satellite networks and surface networks. Only then is it possible to realize interconnection services between two different types of networks. ATM switching devices--for voice and data services respectively--provide line switching and subgroup switching. Speaking in terms of voice services, networks provide transparent transmission. Therefore, the primary object of protocol switchover studies is data transmission services. Considering satellite propagation characteristics--due to the fact that there are no back up routes between transmitting and receiving stations--as a result, network level path switching and congestion control are no longer necessary. As far as information exchange between any two surface stations is concerned, it is, then, simple, being summarized as target address recognition with regard to data

subgroups. Therefore, if the corresponding relationships between VPI and VCI in ATM signal element subgroup markers and various stations and their interconnection modules are set up, it is then possible to realize functions associated with automatic selection of data subgroup target station addresses. In accordance with this idea, protocol switchover is carried out between local area network link level circuit (LLC and MAC) and ATM adaptor levels (AAL). AAL level is composed of service convergence (CS) sublevels and section/assembly sublevels (SAR). Use is made of them to realize service adaptations [4] with regard to AAL3/4 and AAL 5 types. These services include electronic mail, facsimile, graphics, and data transmission services. The structure of network interconnection protocols is a shown in Fig.5. In the Fig., the role of interconnection units (IU) is the carrying out of management with regard to LLC sublevel protocol data units (PDUs). In conjunction with this, in accordance with fixed formats, it is required to take PDUs and divide them into groups again after which they are referred to AAL levels to form CS-PDUs. Following that, they are changed over by SAR sublevels into SAR-PDUs. In conjunction with that, they are sent to ATM level, constructing ATM signal element information domains. After going through subgroup time division reutilization, they are sent to transmitters and then imputed into satellite communications channels. As far as receiving sides are concerned, the processes of protocol switchover are just the reverse of the processes described above. It is possible to see the role of IU as the same as a net switch. It completes interconnection switchovers between services that lack connections and services geared to interconnections. Fig.6 clearly shows AAL level loading and unloading processes with regard to subgroup data.

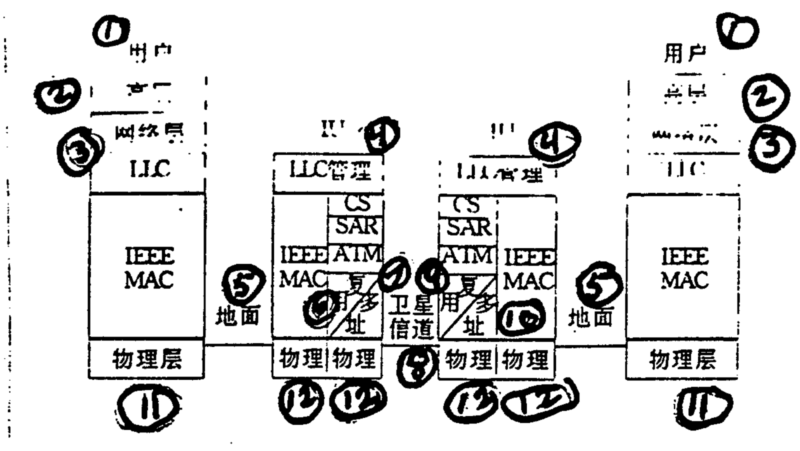

Fig.5 Net Interconnection Protocol Structure (1) User (2) High Level (3) Network Level (4) Management (5) Surface (6) Reutilization (7) Multiple Address (8) Satellite Communications (9) Reutilization (10) Multiple Address (11) Physics Level (12) Physics

The management of entire satellite networks can be divided into two levels--that is, high level management and low level management. They are, respectively, implemented by central stations and substations. The contents of high level management include network architecture management, equipment management, security management, as well as operating management and control. The function of network architecture management is primarily to precisely determine equipment deployment within networks as well as system parameters associated with various individual units. In conjunction with this, through operating personnel making use of architecture management, such functions as increases and reductions of surface stations and their terminals, increases and decreases in network connections, start ups and close downs of constituent parts of networks, as well as improving network software, and so on are completed. Equipment management functions are primarily used in the selection of equipment for use in networks, the carrying out of the registry of equipment and reserve equipment, as well as the keeping of equipment inventories, so as to facilitate the use of management in control and maintenance. Security management involves the management of code keys and is capable of preventing unauthorized users from making use of network resources and equipment. In conjunction with this, it causes parts of networks that have already been abandoned to be invalidated and prohibits the use of certain dangerous parts of network security software and hardware resources. Besides this, security management also carries out the handling of unusual situations--for example, satellite communications blockages, network malfunctions, and so on. Operating management systems are for guaranteeing normal and effective operation of networks as a whole and are indispensable. They normally collect and, in conjunction with that, maintain network status and performance data in order to facilitate the carrying out of timely monitoring with regard to networks--for instance, providing coordination in respect to transmission powers of various stations, as well as transmission frequencies, operating configurations and net entry methods, priority levels for service allocations, and so on, making them conform to regulation requirements. The low level of management pertains to management of user networks. It primarily includes such content as accounts management, user terminal equipment management, connection set up and communications channel allocation management, as well as management of flow control and sharing of resources, etc. /6

High level network management is capable of making use of satellite broadcast characteristics, opting for the use of dedicated broadcast communications channels for realization. For instance, stipulating a set of logic channels possessing specially designated VPI or VCI values to act as broadcast channels for central stations to send commands to various stations--after all the stations or part of the stations simultaneously identify the specially designated VPI or VCI values--they pick out management information from among signal elements. In conjunction with this, the stipulated control functions are implemented. Speaking in terms of network monitoring, it is, by contrast, after the

detection and calculations are carried out from configuration information among subgroup data sent out by various stations and received through central stations and it is sent to network control computers for processing in order to precisely determine whether or not the network is operating normally. The two levels of network management--high and low--require carrying out communications. It is only in this way that it is possible to mutually coordinate operations, guaranteeing the normal operation of networks as a whole.

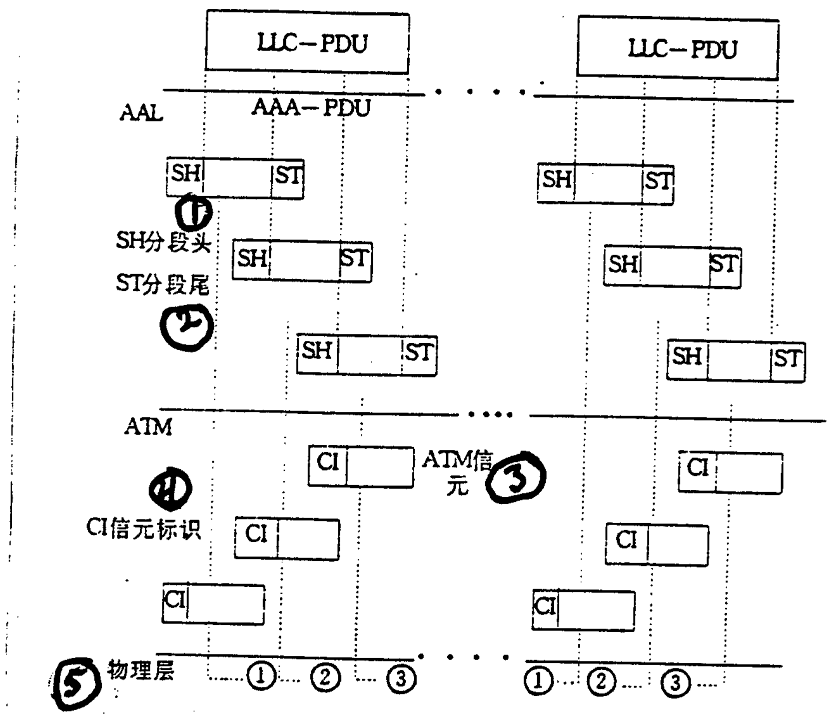

Fig.6 AAL Level Unloading/Loading Processes for Subgroup Data (1) Subsection Header (2) Subsection Tail (3) Signal Element (4) Signal Element Identifier (5) Physics Level

V. CONCLUDING REMARKS

/48

We have explored the path associated with opting for the use of ATM modes in satellite transmission services to realize integrated broad band communications networks (IBCN). This type of IBCN communications system is a frequency division multiple address system (FDMA) associated with signal element multichannel reutilization. Through satellites, it takes specialized use networks which are comparatively widely separated in geographical terms or which there is no way for surface wiring to reach and connects them together in order to fit application situations where amounts of data services are large and numbers of ground stations are middling. Due to the fact that FDMA technology is mature, equipment prices are inexpensive, and there is no need for overall network synchronicity, therefore, the entire network system is comparatively simple and easy to realize. Moreover, ATM modes act as information transmission methods, guaranteeing maximum future compatibility with ISDN--advantageous for step by step development. These advantages discussed above are very suitable for use in the national situation of China. In conjunction with this, it attracts people's attention more and more. As a result, great efforts are exerted in the opening up of the new realm of satellite communications, actively developing applications research with regard to IBCN. This possesses very important significance for the rapid altering of China's deficiencies in fundamental telecommunications facilities and the backward state of the communications situation.

REFERENCES

1 王秉钧. 小型站卫星通信系统. 天津科学技术出版社:1992

2 Linge N, Ball E and Ashworth J. Achieving Network Interconnection Using Satellite Services. IEE. ECSC-3, 165169, 1993 09

3 Liberg Y. Metroplitan Area Network - Concepts, Architecture and Evolution towards B - ISDN. IFIP 1990

4 Hadjitheodosiou M H, Smythe C. End - to - end Performance Analysis for Broad - band Island Interconnection via Satellite - RACE II /R2074(Catalyst) Project. IEE. ECSC - 3, 170174, 1993 09

Brief Introduction of the Author

Duan Xiaoming graduated from the graduate school of Northwestern Industrial College in 1989, obtaining an Masters degree. At the present time, he works in the national integrated services network emphasis laboratory of Xian Electronic Science and Technology College. In conjunction with that, he is reading for his doctoral degree on the job. He is mainly engaged in research in the areas of B-ISDN and VSAT satellite communications and mobile communications.